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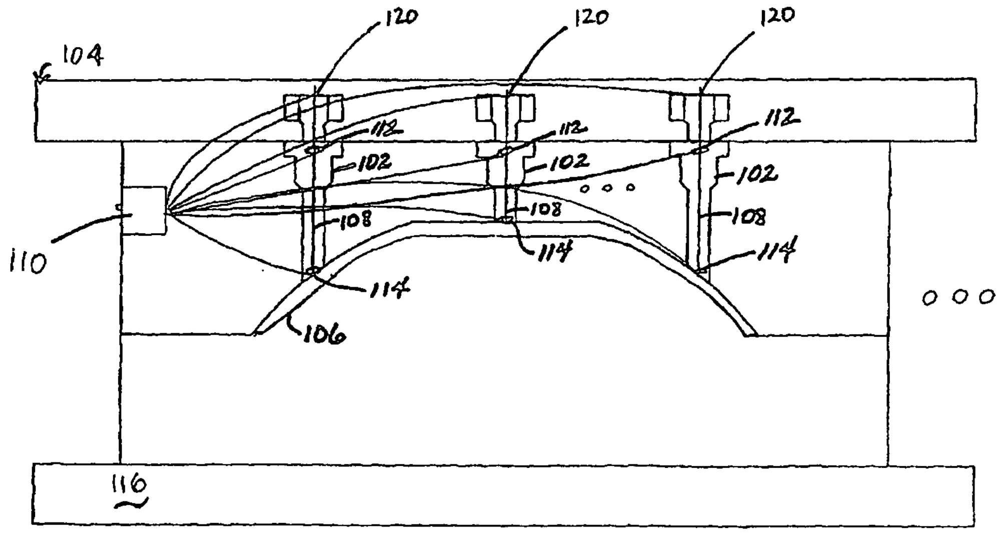
(54) Title: VALVE-PIN POSITION MONITORING SYSTEM



(57) **Abstract:** The present invention provides a method, a valve gating apparatus, and article of manufacture, and a mold gate for a multi-cavity injection molding system for molding a plurality of components and providing an alert or fault signal if a valve-pin is out-of-place. The method includes the steps of: transferring a melt pool of injection molding material into at least one mold gate; filling at least one mold using the mold gate, each having a nozzle drop (216) with a moveable valve-pin (108); monitoring the position of each valve-pin using at least one sensor (208, 210) for each valve-pin; providing control signals for chaging a position of each valve-pin in accordance with a predetermined scheme for injection molding; and using the sensor(s) for monitoring the position of the valve-pins, wherein when the position of a valve-pin varies from the predetermined scheme, a fault signal is generated.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

VALVE-PIN POSITION MONITORING SYSTEM

PRIORITY CLAIM

Priority is claimed to U.S. Provisional Application Serial No. 60/269,997 filed on February 20, 2001, entitled 'Valve-Pin Position Monitoring System'.

FIELD OF THE INVENTION

The present invention relates generally to valve gating in an injection-molding apparatus, and more particularly to monitoring the position of a valve-pin for a valve gating apparatus in an injection-molding apparatus.

BACKGROUND OF THE INVENTION

Injection molding techniques have been utilized for a number of years. For the process of inserting molten material into the cavity of a mold so that a molded part may be formed, allowed to cool and then removed from the mold, certain techniques are known for controlling the flow of the molten material. In particular, two methods of controlling the flow of the molten material are well known: thermal gating and valve gating.

Thermal gating is accomplished by cooling the molten material rapidly at the exit point of the nozzle when injection of the molten material is completed so that a plug of the material is formed at the gate. The plug of material is then generally removed from the molded part.

Valve gating systems typically use a mechanical mechanism to inhibit the flow of the molten material into the mold cavity.

United States Patent No. 5,762,855 describes a valve gating method for molding large components in a mold having at least one mold cavity. Plasticized material is introduced into a single cavity mold through a manifold. The manifold has at least two spaced valve gates that are independently opened and closed as directed by a controller to selectively communicate plasticized material from the manifold to the mold cavity at separate locations in the mold cavity. The controller directs the valve gates to sequentially open and close during the filling phase so as to achieve the desired melt front advancement within the mold cavity. Once the mold cavity has been filled, the valve gates are closed to effectively seal the manifold from the mold cavity. The closed valve gates thereby assist in allowing the plasticized material within the manifold to be held in compression while the mold cavity is open for removal of the molded component from the mold cavity, so as to prevent appreciable expansion of the material that has been found to result in imperfections, such as splay, in molded products.

Generally, valve gating systems are either lateral or inline systems. A lateral system of valve gating moves the valve in a perpendicular direction with respect to the flow of the molten material, thus blocking or allowing the flow of the molten material through the valve. However, if a lateral valve gate is located too far from the mold cavity, sprue formation may be altered.

An inline system has a valve-pin inside the injection nozzle that is extended into the gate to block the flow of the molten material and is withdrawn from the injection nozzle to allow the molten material to flow into the mold cavity.

Where the valve-pin sticks, breaks off, or is not positioned correctly, the molding system is unaware that the valve-pin is incapacitated and continues to mold parts that have flaws due to the incapacitated valve-pin, causing molding material to be wasted and manufacturing efficiency to be reduced. Thus, there is a need for providing a valve-pin position monitoring method and apparatus that alerts the molding system immediately when a valve-pin becomes incapacitated.

SUMMARY OF THE INVENTION

The invention provides for utilizing information that discloses valve-pin positions in the mold of a valve gating apparatus during sequential filling of at least one injection mold in an injection molding system. Monitoring the positions of the valve-pins allows the user to terminate the molding manufacturing process immediately upon finding that a valve-pin is missing, broken or improperly placed. In contrast to prior art manufacturing processes in which the user might make a number of molded articles before becoming aware that the articles were flawed due to a valve-pin being incapacitated, with the present invention the user may terminate the process immediately upon the monitoring system's indicating that a valve-pin is incapacitated. In this manner, both molding material and manufacturing time are conserved.

In the present invention, the valve gating apparatus includes a manifold that is coupled to transfer a melt pool of injection molding material into at least one mold gate. Each mold gate has a nozzle drop with at least one valve-pin within that is moveable in a direction parallel to a flow path of the melt pool. Sensors are located proximate to the valve-pins, typically near each end of a valve-pin. The sensors are used to monitor the position of the valve-pin. In a preferred embodiment, the nozzle drop is tapered.

The valve-pins are coupled to receive control signals from a control device, wherein the control signals cause the valve-pins to change position in accordance with a predetermined scheme for injection molding. In addition, at least one sensor for the at least one valve-pin monitors the position of the at least one valve-pin. Generally, there may be a sensor located proximate to each end of a valve-pin. Where the sensor indicates that the position of a valve-pin varies by at least a predetermined amount, the control device may send an alert a valve-pin is out-of-place, or, alternatively, may simply shut down the molding operation.

The present invention may be implemented in an article of manufacture with a multi-cavity injection molding system for injection molding a plurality of components. Generally, a computer unit sends control signals to the multi-cavity injection molding system, and an injection molding system is coupled to send and receive signals to and from the computing unit so that valve-pin position information is sent to the computing unit during molding of a plurality of vehicle components. The injection molding system typically includes more than one mold cavity space, and each mold cavity space has at least one valve gating apparatus that is used for sequentially filling an injection mold. Each valve gating apparatus is generally as described above.

In addition, in one embodiment the method of the invention may be implemented by following the following steps: transferring a melt pool of injection molding material into at least one mold gate; using, to fill at least one mold, the at least one mold gate, where each mold gate has a nozzle drop with at least one valve-pin within that is moveable in a direction parallel to sides of the nozzle drop; monitoring the position of the at least one valve-pin using at least one sensor for the at least one valve-pin; providing control signals to the at least one valve-pin for changing a position of the at least one valve-pin in accordance with a predetermined scheme for injection molding; and using the at least one sensor for the at least one valve-pin for monitoring the position of the at least one valve-pin and, where the position of the at least one valve-pin varies by at least a predetermined amount, indicating that the at least one valve-pin is out-of-place. In a preferred embodiment, the nozzle drop is tapered.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary of the invention, as well as the following detailed description of preferred embodiments, is better understood when read in conjunction with the accompanying drawings, which are included by way of example, and not by way of limitation with regard to the claimed invention.

Figure 1 illustrates a cross-sectional side view of one embodiment of a multi-mold, valve-gated injection system with a valve-pin position monitoring system in accordance with the present invention.

Figure 2 is a schematic representation of a cross-sectional view of one embodiment of a valve gating apparatus coupled to a valve-pin position monitoring system in accordance with the present invention.

Figure 3 shows a flow chart for one embodiment of steps of a method in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention provides for more precise monitoring of molding in an injection molding system. Valve-pins may become jammed in a wrong position, fail to advance to the correct position to allow the desired communication of melted material to be sent to the mold, and/or may break, and thus fail to control the delivery of the proper amount of melted material to the mold. By sensing valve-pin malfunction immediately when the valve-pin breaks or fails to move into the desired position, the control system may shut down the manufacturing process quickly, avoiding the subsequent production of a number of malformed molded parts. Alternatively, when a valve-pin malfunctions, the control system may sound an audio alarm and/or provide a visual alarm so that the manufacturing system may be shut down manually.

Figure 1 illustrates a cross-sectional side view of one embodiment of a valve-gated injection system with a valve-pin position monitoring system in accordance with the present invention. In the example shown in Figure 1, the valve-gated injection system has a hot runner manifold with an inlet and a plurality of outlets, as is well known in the art. A plurality of nozzle drops 102 extend from the cavity backplate 104 into the first mold cavity 106. A core backplate 116 forms the rear side of the first mold cavity 106.

Each nozzle drop 102 has a housing defining a channel (217 on Fig. 2) extending from an inlet to an outlet. Valve-pin 108 is operably mounted in the channel for reciprocating movement between an open position and a closed position. A corresponding driver or solenoid 120 is mounted in the cavity backplate 104 outside of the channel and is operably connected to the valve-pin 108 to effect the reciprocating movement. The driver 120 is coupled to a control device 110.

The control device sends control signals to each nozzle drop 102 to move the valve-pins between open and closed positions in accordance with a predetermined manufacturing scheme that provides for injection of the desired amount of melted material into a mold cavity at predetermined times and locations. In addition to providing signals to the valve-pins 108 to cause the pins to reciprocate, the control device 110 monitors the positions of the valve-pins 108 to determine whether a valve-pin is in an undesirable position, broken, or is missing.

Preferably, the nozzle drop 102 has at least one sensor 112 (or 114) that is positioned at the upper end region and/or at the bottom end region of the valve-pins. Sensors 112, 114 generate signals to the control device 110. The control device utilizes the signals to determine when a valve is open, when the valve is closed, when the valve should be closed but is not closed, and when a valve should be open but is not open. By providing immediate feedback from the sensors 112, 114 to the control device 110, the present invention improves the injection molding process by allowing the process to be modified to avoid the molding condition impaired by an incapacitated valve-pin or even stopped completely.

Often, a poorly formed molded article may not be recycled. Thus, there is less wasted material. Also, the efficiency of the molding machine, i.e., the number of correctly-formed articles being made when compared with the total number of articles being molded, increases. A pair of sensors, with each sensor located near an end region of the valve pin, can be particularly useful to identify when the valve pin is broken or misaligned. When two or more such sensors are used for each valve pin, each sensor can generate independent signals corresponding to the valve pin position. Thus, if a valve pin is broken or misaligned, at least one sensor will identify that the valve-pin is not moving in accordance with the predetermined scheme and provide this information to the control device 110. Suitable sensors for use in the present invention include, but are not limited to, proximity sensors, pressure sensors, capacitor sensors, and Hall effect sensors.

Figure 2 is a schematic representation of a cross-sectional view of one embodiment of a valve gating apparatus coupled to a valve-pin position monitoring system in accordance with the present invention. Each nozzle drop 216 has a housing 215 defining a channel 217 extending from an inlet to an outlet. The inlet communicates with the manifold 212 to receive melt of the injection molding material. Nozzle drop 216 is mounted in a cavity 219 formed in the mold half.

Valve-pin 212 is operably mounted in the channel 217 for reciprocating movement between an open position and a closed position. A corresponding driver or solenoid 221 is mounted in a cavity 223 in the backplate 203 outside of the channel and is operably connected to the valve-pin 212 to effect the reciprocating movement. Valve-pin 212 extends through the backplate 203 into the channel 217. The driver 221 is coupled to a control device 202.

In this embodiment the control device 202 has a plurality of different colored lights, preferably light-emitting diodes 204, which may, for example, be red, yellow and green. Clearly, the light-emitting diodes may be of any selected color, or may simply be white, with labels showing their meaning. The light-emitting diodes can be used to provide a visual alarm signal, such as when there is a malfunction. Those of skill in the art will recognize that control device 202 may include other signal components, such as other visual and/or audio alarms. Thus, control device 202 can include any signal device or component that will identify to an operator when a malfunction occurs and/or when a particular operating condition occurs. Further, control device 202 can responsively slow down or discontinue operation of the valve gating apparatus until the malfunction is rectified. An optional press logic control unit 206 can be used to allow manual input.

Sensors 208, 210 at the upper and lower portions of the valve-pin 212 are coupled to the control device 202. The sensors 208, 210 are used to monitor the position of the valve-pin 212 and send signals to the control device 202 indicating the position of the valve-pin 212. The hot runner manifold 214 transfers molten material to the inlet of the channel defined by the housing of the nozzle drop 216 and the valve-pin 212 controls the flow of the molten material through the outlet to the mold (not shown).

If a sensor sends a signal to the control device indicating that a valve-pin is incorrectly positioned, the control device 202 may provide an alert or fault signal, such as an audio signal, a visual signal, or both, and/or may shut down the molding process. In this manner, molding material is not wasted by molding articles using an out-of-place valve-pin. Further manufacturing time is not wasted in making defective articles.

Figure 3 shows a flow chart for one embodiment of steps of a method in accordance with the present invention. The method provides for valve-pin position information to be sent from a valve gating apparatus that sequentially fills at least one injection mold in an injection molding system so that the molding manufacturing process may be interrupted immediately when a valve-pin is out-of-place or broken. The method includes the steps of: transferring 302 a melt pool of injection molding material into at least one mold gate; using 304 the at least one mold gate to fill at least one mold, where each mold gate has a tapered nozzle drop with a valve-pin within that is moveable in a direction parallel to sides of the tapered nozzle drop; monitoring 306 the position of each valve-pin using at least one sensor for each valve-pin; providing control signals 308 to the valve-pin for changing a position of each valve-pin in accordance with a predetermined scheme for injection molding; and using 310 the at least one sensor for each valve-pin for monitoring the position of the valve-pin and, where the position of a valve-pin varies by at least a predetermined amount, providing an alert indicating that the valve-pin is out-of-place.

In one embodiment, the position of a valve-pin is indicated by one of a plurality of different lights, preferably light emitting diodes (LEDs), each LED indicating a different position for the valve-pin. Where the position of a valve-pin varies by at least a predetermined amount, the control device may alert the user by emitting an audio alert signal, emitting a visual alert signal, and/or may shut down the injection molding system. Generally, more than one valve gating apparatus is used, thus providing more even filling and faster filling of the mold. Also, by typically utilizing a multi-cavity injection molding system, the injection molding system provides a higher molded article output rate.

Although the present invention has been described in relation to particular preferred embodiments thereof, many variations, equivalents, modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.

CLAIMS

What is claimed is:

1. A nozzle drop for an injection molding system, comprising:

a housing having an inlet and an outlet and a channel extending therebetween,

a valve-pin operably mounted to move between an open position and a closed position to control flow of melt through from the inlet, through the channel and out the outlet;

a driver coupled to the valve-pin for effecting said movement; and

a first sensor proximate to the valve-pin for monitoring the position of the valve-pin and generating a valve-pin position signal responsive thereto.

2. The nozzle drop of Claim 1 wherein said first sensor is positioned at an end region of the valve pin.

3. The nozzle drop of Claim 2 further comprising a second sensor proximate to the valve-pin for monitoring the position thereof and generating a valve-pin position signal responsive thereto, said second sensor positioned at an end region of the valve-pin opposite said first sensor.

4. A valve gating apparatus for providing valve-pin position information during valve gating in an injection molding system, comprising:

a manifold having a runner comprising an inlet and a plurality of outlets;

a plurality of nozzle drops coupled to the manifold in each of the outlets, where each of said plurality of nozzle drops has a valve-pin that is moveable between an open position and a closed position to control flow of melt through the nozzle drop and a driver coupled to the valve-pin for effecting said movement; and

a first sensor proximate to each of the valve-pins for monitoring the position of the valve-pin and generating a valve-pin position signal responsive thereto.

5. The valve gating apparatus of Claim 4 wherein said first sensor is positioned at an end region of the valve pin.

6. The valve gating apparatus of Claim 5 wherein each nozzle drop further comprises a second sensor proximate to the valve-pin for monitoring the position thereof and generating a

valve-pin position signal responsive thereto, said second sensor positioned at an end region of the valve-pin opposite said first sensor.

7. The valve gating apparatus of Claim 6 wherein said valve gating apparatus further comprises a control device, coupled to each of the nozzle drops to effect said movement in accordance with a predetermined valve gating scheme for injection molding and to each of the sensors for receiving said valve-pin position signals and comparing said valve-pin position signals with said predetermined scheme, wherein when the position of any of the valve-pins varies from said predetermined scheme, said control device generates a fault signal.

8. The valve gating apparatus of Claim 7 wherein the fault signal is an audio signal, a visual signal, or both.

9. The valve gating apparatus of Claim 7 wherein the control device discontinues operation of the molding system in response to the fault signal.

10. The valve gating apparatus of Claim 7, wherein each of the nozzle drops are tapered.

11. An injection molding system for providing valve-pin position information during molding, comprising:

a mold having at least one mold cavity;

a manifold having a runner comprising an inlet and plurality of outlets, said plurality of outlets communicating with said at least one mold cavity; a nozzle drop coupled to the manifold in each of the plurality of outlets, where each nozzle drop has a valve-pin that is moveable between an open position and a closed position to control flow of melt through the nozzle drop and into the at least one mold cavity and a driver coupled to the valve-pin for effecting said movement;

a plurality of sensors proximate to each of the valve-pins for monitoring the position of the valve-pins and generating a plurality of valve-pin position signals responsive thereto; and

a control device, coupled to the drive for providing control signals thereto to effect movement of the valve-pins in accordance with a predetermined scheme for injection molding and to the plurality of sensors for receiving said valve-pin position signals and comparing each of said valve-pin position signals with said predetermined scheme, wherein when the position of any of the valve-pins varies from said predetermined scheme, said control device generates a fault signal.

12. The injection molding system of Claim 11 wherein each nozzle drop has a first and second sensor located at opposite end regions of said valve-pin.

13. The injection molding system of Claim 12, wherein the nozzle drop is tapered.

14. A method for controlling a valve gating apparatus that fills at least one injection mold cavity according to a predetermined scheme, the method comprising the steps of:

providing a plurality of nozzle drops, each nozzle drop having a valve-pin moveable between an open position and a closed position, a drive coupled to the valve-pin effecting movement thereof in accordance with a predetermined scheme for injection molding, and a first sensor proximate to the valve-pin for monitoring a position thereof;

sending a series of control signals to each of said nozzle drops to fill said mold cavity with a melt of injection molding material in accordance with said predetermined scheme;

generating a series of signals corresponding to valve-pin position for each nozzle drop during said fill; and

comparing the valve-pin signals with said predetermined scheme.

15. The method of Claim 14 further comprising a step of generating a fault signal when the valve-pin signals varies from said predetermined scheme.

16. The method of Claim 15 wherein the fault signal is an audio signal, a visual signal, or both.

17. The method of Claim 15 wherein said step of generating includes responsively illuminating a plurality of different colored lights, each indicating a different position for the valve-pin.

18. The method of Claim 15 wherein said method further comprises a step of discontinuing operation of the injection molding system until the fault signal is rectified.

19. The method as claimed in Claim 15 wherein said nozzle drops further comprises a second sensor proximate to each of the valve-pins, said second sensor positioned at an end region of the valve-pin opposite said first sensor.

20. The method of Claim 19 wherein said method further comprises a step of discontinuing operation of the injection molding system until the fault signal is rectified.

21. The method of Claim 20 wherein said step of generating includes responsively illuminating a plurality of different colored lights, each indicating a different position for the valve-pin.

22. The method of Claim 14, wherein the nozzle drops are tapered.

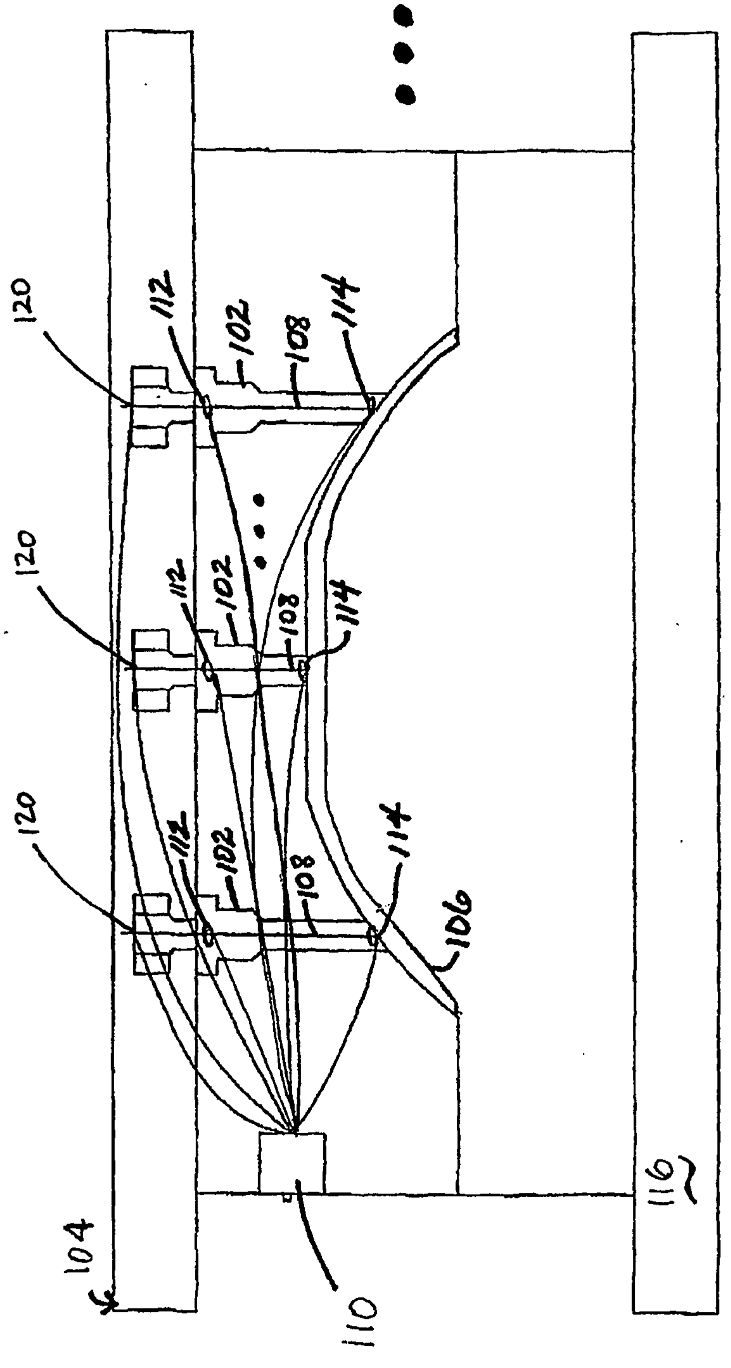
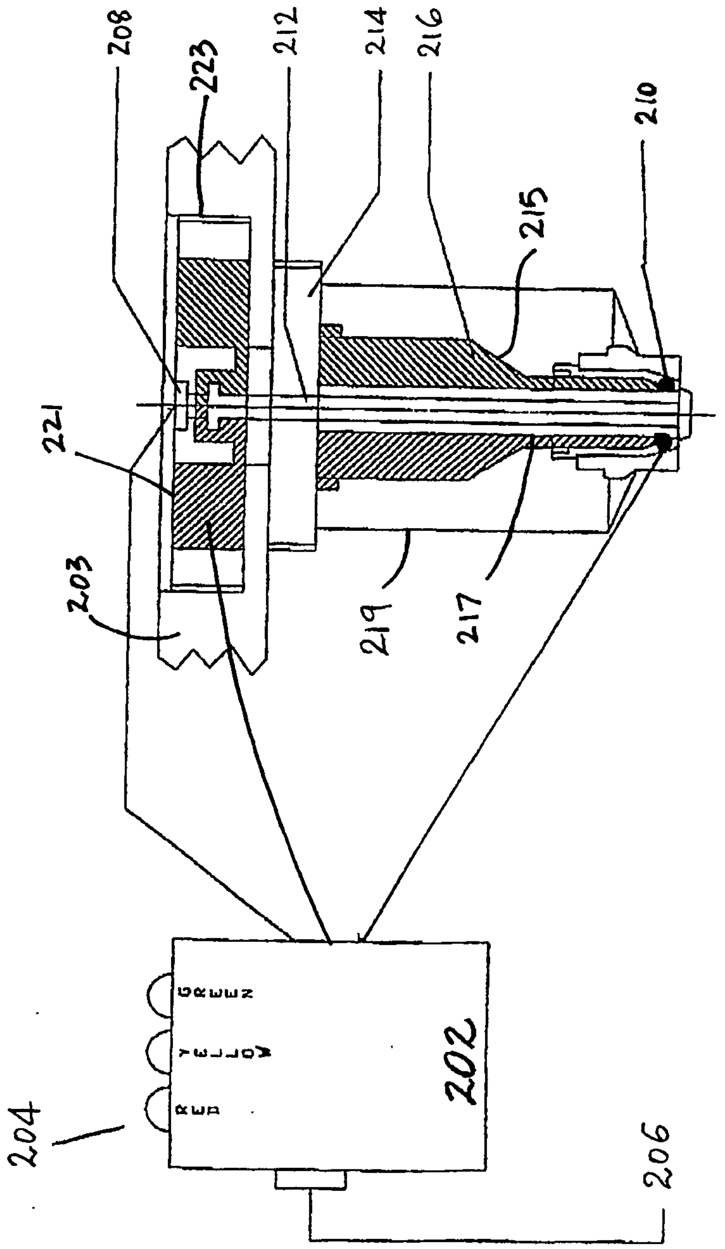


Figure 1

Figure 2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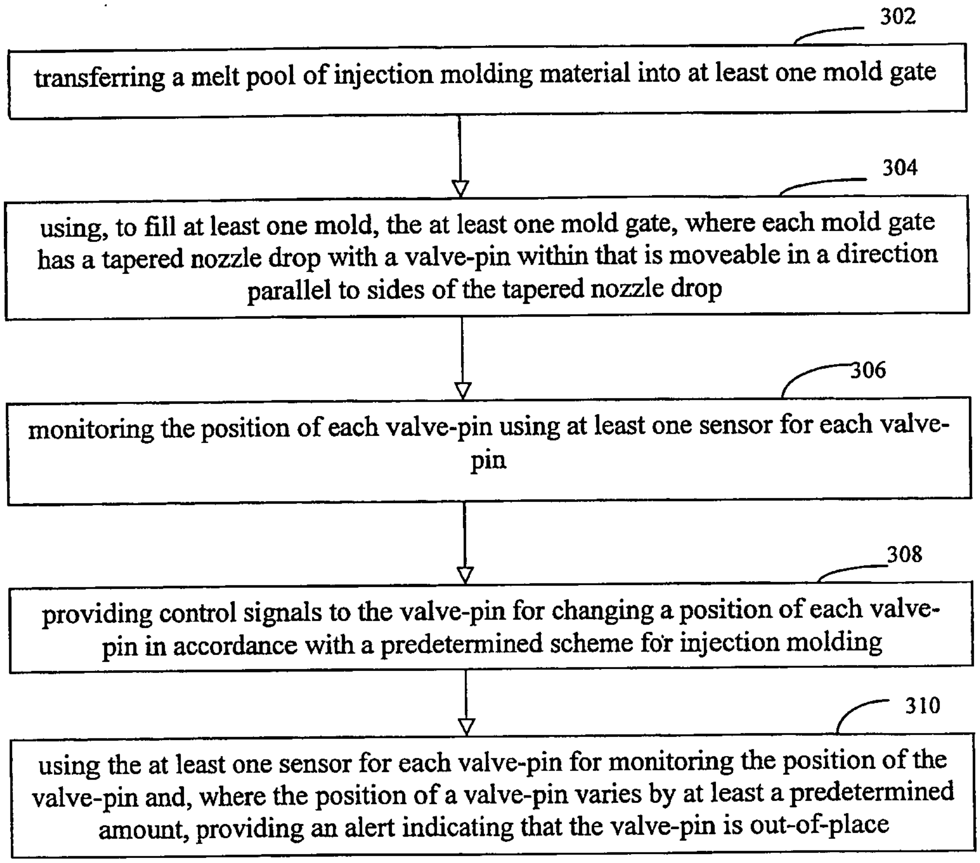
302
transferring a melt pool of injection molding material into at least one mold gate
304
using, to fill at least one mold, the at least one mold gate, where each mold gate has a tapered nozzle drop with a valve-pin within that is moveable in a direction parallel to sides of the tapered nozzle drop
306
monitoring the position of each valve-pin using at least one sensor for each valve-pin
308
providing control signals to the valve-pin for changing a position of each valve-pin in accordance with a predetermined scheme for injection molding
310
using the at least one sensor for each valve-pin for monitoring the position of the valve-pin and, where the position of a valve-pin varies by at least a predetermined amount, providing an alert indicating that the valve-pin is out-of-place

Figure 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/05730

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B29C 45/23
US CL : 264/40.1, 328.8, 328.12; 425/136,145, 169, 171,572, 573
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 264/40.1, 328.8, 328.12; 425/145, 572, 573

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,556,582 A (KAZMER) 17 September 1996, Figs. 1 and 2.	1,2,4,5,14,15,22
Y		3,6,7,10-13,19
X	US 5,055,026 A (GORDON) 08 October 1991, Figs. 1-4.	1,2,4,5,14,15,22
Y		3,6,7,10-13, 19
Y	US 5,283,018 A (INABA et al) 01 February 1994, col. 6, lines 63-65.	9,18,20

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance		
"E"	earlier document published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means		
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,099,767 A (TARR et al.) 08 August 2000, Figs. 7-12.	8,16,17,21